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(54) Protective relaying methods and apparatus.

(57) The invention provides methods and apparatus for detecting a single-phase-to-ground fault on a three-phase electrical power system, and for identifying a faulted phase. A single-phase-to-ground fault is correctly distinguished from other faults, including phase-to-phase-to-ground faults, even with transmission lines which utilize series capacitors, by taking into consideration the phase-to-phase voltage which is in quadrature with the voltage to ground of the monitored phase.

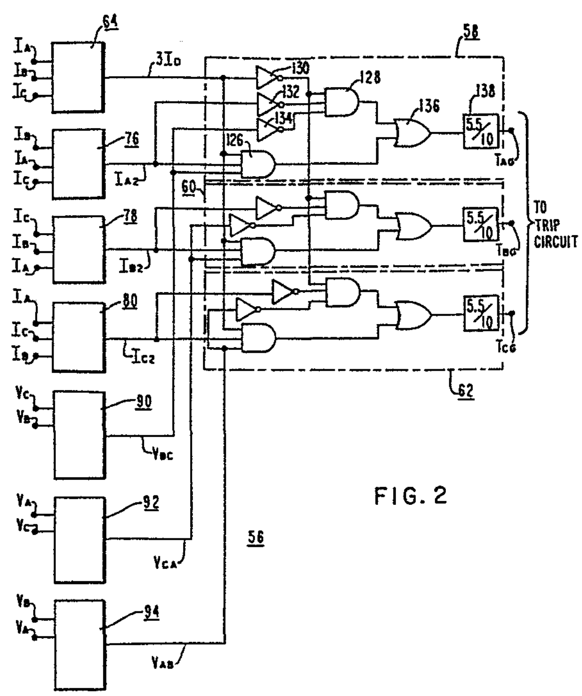

FIG. 2

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Düsseldorf, Nov. 2, 1982

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PROTECTIVE RELAYING METHODS AND APPARATUS

The invention relates in general to protective relaying methods and apparatus, and more specifically to methods and apparatus for detecting a single-phase-to-ground fault on a three-phase electrical power system, and for identifying the faulted phase.

Faults on three-phase electrical power transmission lines are usually transient single-phase-to-ground faults, which can be cleared by opening and high-speed reclosing of only the phase associated with the fault. Single-pole tripping enables synchronizing power to be exchanged between the other two phases, and it minimizes system shock. A large generation plant, for example, connected to the electrical power system via a single transmission line retains synchronization when single-pole tripping is used, as opposed to three-pole tripping. Three-pole tripping requires the machines to be resynchronized before reconnection.

In single-pole tripping, the protective relays must be able to distinguish a single-phase-to-ground fault from a phase-to-phase fault, a double-phase-to-ground fault, and three-phase faults, and correctly identify the faulted phase. One prior art approach uses current level detectors in each of the three phases of a transmission line. A phase-to-ground fault is identified when one current is high and the other two currents are low. This method has certain disadvantages, however, as accurate phase selection is only possible when the fault current reliably and appreciably exceeds load current, and the symmetrical component distribution factors are similar in the positive and zero sequence networks.

Another prior art approach takes advantage of the fact that for single-phase-to-ground faults, the negative and zero sequence currents are essentially in-phase for the faulted phase, and essentially 120° out of phase for the unfaulted phases. This concept, however, cannot be used without additional relaying units which distinguish between a single-phase-to-ground fault and a phase-to-phase-to-ground fault, as in the latter, the negative and zero sequence currents are essentially in-phase for the phase which is not involved in the fault. For example, an additional relaying unit may be provided which senses the magnitudes of the three phase-to-ground voltages. This relaying unit is set to operate only when one voltage is higher than the other two, thus identifying a phase-to-phase-to-ground fault. This relaying unit thus overrides the selection of a single pole by the phase selector relay, and causes all three poles to trip. While satisfactory operation can be obtained with this arrangement, the application is difficult because of the choice of levels for "high" and "low" voltages, and what difference value is a suitable criterion for making a decision that a phase-to-phase-to-ground fault exists.

The chief object of the present invention is to provide improved protective relaying methods and apparatus for detecting a single-phase-to-ground fault, and for identifying the faulted phase, which methods and apparatus are not critically dependent upon the selection of analog magnitude values, and their differences, for proper setup and operation.

With this object in view, the invention resides in a method of detecting a single-phase-to-ground fault in a three-phase electrical power system, comprising the steps of:

providing a first phasor signal responsive to the sum of the three phase currents in the three-phase system,

providing a second phasor signal indicative of a predetermined negative sequence quantity, referenced to the phase being monitored,

providing a third phasor signal responsive to the quadrature voltage for the phase being monitored,

comparing the phase angles of said first, second and third phasor signals,

and providing a signal indicating a single-phase-to-ground fault of the monitored phase when the step of comparing the phase angles detects a predetermined phase angle relationship.

The invention further resides in apparatus for detecting a single-phase-to-ground fault in a three-phase electrical power system according to the above method, comprising apparatus for detecting a single-phase-to-ground fault in a three-phase electrical power system, operating according to the above method, comprising:

means providing a first phasor signal responsive to unbalanced current in the three-phase system,

means providing a second phasor signal indicative of a negative sequence quantity, referenced to the phase being monitored,

means providing a third phasor signal responsive to the quadrature voltage of the phase being monitored,

comparison means comparing the phase angles of said first, second and third phasor signals,

said comparison means providing a signal which indicates a single-phase-to-ground fault on the three-phase system, with the fault being on the phase being monitored, when the phase angles have a predetermined relationship.

The invention will become more readily apparent from the following exemplary description taken in connection with the accompanying drawings, in which:

Figure 1 is a schematic diagram of a three-phase, alternating voltage, electrical power transmission line, illustrating a protective relaying system which may utilize the teachings of the invention;

Figure 2 is a partially schematic and partially block diagram of protective relaying apparatus constructed according to the teachings of the invention, which may be used in the protective relaying system of Figure 1;

Figure 3 is a schematic diagram of apparatus which may be used for a function shown in block form in Figure 2, for providing a signal proportional to the $3I_0$ ground or residual unbalanced current;

Figure 4 is a schematic diagram of a circuit which may be used for functions shown in block form in Figure 2, for providing signals proportional to the negative sequence currents;

Figure 4A is a schematic diagram of a phase shift circuit which may be used to shift the output of the circuit shown in Figure 4 by 90° CCW, when the circuit is used to provide signals proportional to the negative sequence voltages;

Figure 5 is a schematic diagram of apparatus which may be used for functions shown in block form in Figure 2, for providing signals proportional to the quadrature voltages;

Figure 6 is a phasor diagram which illustrates the quadrature voltage V_{BC} for phase V_A;

Figure 7 is a phasor diagram which illustrates the phase A monitoring signals for a phase A-to-ground fault (AG);

Figure 8 is a graph which illustrates the positive and negative coincidence of certain signals which indicate the phase associated with the signals is the faulted phase of a single-phase-to-ground fault on the associated electrical power system;

Figures 9A and 9B are phasor diagrams which illustrate the phase B and phase C monitoring signals, respectively, for an AG fault;

Figure 10 is a phasor diagram which illustrates signals associated with the phase A monitor for a BCG fault, when the net impedance to the monitoring point from the fault is inductive; and

Figure 11 is a chart which sets forth various phasor signals for different fault configurations, referenced to the phase A monitor.

Briefly, the present disclosure reveals improved methods and apparatus for detecting a single-phase-to-ground fault on a three-phase electrical power system, and for identifying the faulted phase. Each phase is monitored using phasor signals responsive to (1) the sum of the three phase currents, (2) the negative sequence current referenced to the monitored phase, and (3) the phase-to-phase voltage, which is in quadrature with the phase-to-ground voltage of the monitored phase. A predetermined phase angle relationship between these three phasor signals for a phase indicates the system has a single-phase-to-ground fault, with the identified phase being the faulted phase.

The present invention relates only to methods and apparatus for identifying a single-phase-to-ground fault, and for identifying the phase involved in such a fault. Other relays are required to use this information in a complete protective relaying system. Since the additional relays required depend upon the specific application, and are well known in the art, they will not be shown or described in detail. For example, if the apparatus of the invention is to be used in a single-pole tripping arrangement, the protective relaying system may be of the pilot type, with a suitable system being shown and described on pages 16-23 through 16-25 of a publication entitled "Applied Protective Relaying" © 1979, by Westinghouse Electric Corporation, Relay-Instrument Division, Coral Springs, Florida 33065.

Referring now to the drawings, and to Figure 1 in particular, there is shown a three-phase electrical power transmission line system 20, having phases A, B and C connected to a source 22 of three-phase alternating electrical power, such as 60 Hz. Phases A, B and C are connected to a three-phase electrical power transmission line 24 via power circuit breakers 26, 28 and 30, respectively, with the power circuit breakers having separate operating mechanisms, if they are to be used in a single-pole tripping system.

A protective relaying system 34 provides signals for trip circuits 36 associated with the circuit breakers 26, 28 and 30, in response to the phase currents and phase voltages of the three-phase electrical power system 20. Current transformers 38, 40 and 42 provide current signals responsive to the phase A, B and C currents, respectively, which currents are applied to isolating current transformers in system 34. Resistors across the output windings of these isolating current transformers provide voltage signals responsive to the phase currents. These voltage signals responsive to the phase currents are referred to as I_A, I_B and I_C. Figure 3 illustrates the development of these signals. Voltage transformers 50, 52 and 54 provide voltage signals V_A, V_B and V_C responsive to the phase A, B and C voltages to ground, respectively, which signals are applied to voltage potential transformers in system 34.

Figure 2 is a partially schematic and partially block diagram of protective relaying apparatus 56 constructed according to the teachings of the invention, which may be used in the protective relaying system 34 shown in Figure 1. Apparatus 56 detects a single-phase-to-ground fault, and it identifies the faulted phase.

Before describing apparatus 56 in detail, it will be helpful to briefly set forth the new and improved protective relaying method which is implemented by apparatus 56. The method includes the step of monitoring each phase, with the steps associated with the monitoring of a phase including providing a first phasor signal responsive to the unbalanced or $3I_0$ ground current flowing in the three-phase system, providing a second phasor signal indicative of a negative sequence quantity, referenced to the phase being monitored, and providing a third phasor signal responsive to the line-to-line voltage which is in quadrature with the phase voltage being monitored. The negative sequence quantity may be the negative sequence current, or the negative sequence voltage shifted CCW by 90° (+j). The method then includes the steps of comparing the phase angles of the first, second and third phasor signals, and providing a signal when they are within 60° of one another. When this signal is provided, it indicates the three-phase system has a single-phase-to-ground fault, and that the fault is on the phase associated with the monitor providing the signal.

Returning now to Figure 2, protective relaying apparatus 56 includes phase monitoring means 58, 60, and 62 for phases A, B and C, respectively, which means perform the functions of comparing the phase angles of the first, second and third phasor signals, and for providing an output signal when the phase angles of the compared signals are within 60° of one another.

The first phasor signal, which will be referred to as signal $3I_0$, since it is responsive to the residual ground current, is provided in response to signals I_A, I_B and I_C by means shown generally at 64. Suitable means 64 for providing signal $3I_0$ is shown in Figure 3. An operational amplifier (op amp) 66 is connected as an adder, with signals I_A, I_B and I_C being developed from the outputs of current transformers 38, 40 and 42, respectively, via CT and resistor arrangements 65, 67 and 69, respectively. Signals I_A, I_B and I_C are applied to the inverting input of op amp 66 through resistors 68, 70 and 72, respectively. A feedback resistor 74 connects its output to the inverting input, and its non-inverting input is connected to ground. The output voltage $-3I_0$, which may be inverted by a polarity inverter to $3I_0$, is equal to the sum of signals I_A, I_B and I_C, which sum is zero when the system is balanced. Any system unbalance involving a ground produces a signal $3I_0$ having a magnitude proportional to the ground current. The first phasor signal $3I_0$ is applied to each of the phase monitoring means 58, 60 and 62.

The second phasor signal for each phase monitor is related to a negative sequence quantity of the three-phase system, referenced to the monitored phase, and thus a different negative sequence signal is required for each phase monitor. For purposes of example, the negative sequence current is selected for the negative sequence quantity, as it is not necessary to phase shift the negative sequence current after it is derived. While use of the negative sequence current or the negative sequence voltage provide similar results, model power system testing indicates the negative sequence voltage is marginally better behaved with a large source impedance. The negative sequence current signals will be referred to as signals I_{A2}, I_{B2} and I_{C2}, for phases A, B and C, respectively, and they are provided via means 76, 78 and 80, respectively, in response to signals I_A, I_B and I_C. Figure 4 is a schematic diagram of a circuit suitable for providing the negative sequence current referenced to phase A. This same circuit may be used for means 78 and 80 by applying the input signals to the input terminals of Figure 4, starting at the upper terminal, in the order I_C, I_B and I_A for providing signal I_{B2}, and in the order I_A, I_C and I_B, for providing signal I_{C2}. The same circuit with the op amp phase shift network shown in Figure 4A connected to its output may be used to provide the negative sequence voltages, if used instead of the negative sequence currents. Of course, voltage signals will be applied to its inputs, instead of the current related signals.

The circuit shown in Figure 4 for means 76 is the same as that shown and described in U.S. Patent

4,146,913, which is assigned to the same assignee as the present application. The development of the negative sequence signal via this circuit is fully described in this patent, which should be consulted for a more complete understanding thereof. It is sufficient, for purposes of the present invention, to say that a pair of op amps 82 and 84 are required, with op amp 82 being connected to receive signals I_B and I_A at its inverting and non-inverting inputs, respectively, via resistors R'_1 and R_1, respectively. A feedback resistor 1/3 R'_1 connects its output to its inverting input, and a resistor 1/3 R_1 connects its non-inverting input to ground. The output of op amp 82 is thus responsive to $1/3\ (I_A - I_B)$.

Op amp 84 is connected to receive signals I_A, I_B and I_C with signals I_A and I_B being applied to its non-inverting input via resistors R_3 and R'_3, respectively, with signal I_C being applied to its inverting input via a resistor R_2. A feedback resistor 2/3 R_2 is connected from its output to its inverting input, and a resistor 1/3 R_3 is connected from the non-inverting input to ground. Its output provides a signal responsive to $1/3\ (I_A + I_B - 2I_C)$.

A capacitor 86 and a resistor 88 are serially connected between the outputs of op amps 82 and 84, in the recited directional sequence, and their junction provides a signal responsive to $1/3\ (I_A + \alpha^2 I_B + \alpha I_C)$, which is the negative sequence current I_{A2} referenced to phase A. Signal I_{A2} is an input of phase monitoring means 58. In like manner, means 78 and 80 provide signals I_{B2} and I_{C2} for phase monitoring means 60 and 62, respectively.

The third phasor signal for each phase monitor is also referenced to the monitored phase, and a different signal is thus required for each monitor. These signals are referred to as signals V_{BC}, V_{CA} and V_{AB} for the phase A, B and C monitors 58, 60 and 62, respectively, and they are provided via means 90, 92 and 94, respectively. The signal V_{BC} for the phase A monitor 58 is the phase-to-phase voltage, or line-to-line voltage, between the phases not being monitored.

Figure 5 is a schematic diagram of a circuit which may be used by means 90 to produce signal V_{BC} for the phase A monitor 58. The same circuit may be used for means 92 and 94 to provide signals V_{CA} and V_{AB}, respectively, by applying the input signals to the circuit of Figure 5, starting at the upper terminal, in the order V_A V_C for means 92, and in the order V_B V_A for means 94.

The circuit of Figure 5 includes an op amp 96. Op amp 96 is connected as a subtracter, with signals V_B and V_C being applied to its non-inverting and inverting inputs via resistors 104 and 106, respectively, with a feedback resistor 108 connecting its output to its inverting input, and with a resistor 110 connecting its non-inverting input to ground. The output of op amp 96 is thus equal to $V_B - V_C$, which, as shown in the vector diagram of Figure 6, is the phase-to-phase voltage V_{BC}. It will be noted in Figure 6 that the phase-to-phase voltage V_{BC} is 90° out of phase with the phase A voltage V_A, and V_{BC} is thus referred to as the quadrature voltage for phase A.

The phase A monitor 58 compares the phase angles of phasor signals $3I_0$, I_{A2} and V_{BC}. Only the positive half cycles may be compared, only the negative half cycles may be compared, or, as shown in Figure 2, in order to obtain the fastest possible detection, the positive half cycle may be compared with one another, and the negative half cycles may also be compared with one another.

A single-phase-to-ground fault on a three-phase electrical power system will cause the monitored phasors to be within 60° of one another on the faulted phase. The monitored signals will not be within 60° of one another on the sound phases. Further, with a phase-to-phase-to-ground fault, the monitored signals will not be within 60° of one another for any phase.

As shown in the diagram of Figure 8, if the three monitored signals $3I_0$, I_{A2} and V_{BC} are within 60° of one another, the time of positive coincidence will be at least 5.55 msec for a 60 Hz. system, and the time of negative coincidence will be at least 5.55 msec. If the phase angles are closer than 60°, this time will increase, and if the phase angle spread exceeds 60°, this time will decrease. Thus, the phase A monitor may include AND gates 126 and 128, inverter gates 130, 132 and 134, and an OR gate 136. A time-delay unit 138 is also provided which has a pick-up time of 5.55 msec, and a dropout time of 10 msec. If an input signal to unit 138 does not persist for 5.55 msec, the time-delay unit 138 will provide no output. If the input signal persists for at least 5.55 msec, its output will go high and persist for 10 msec following the termination of the input signal.

Phasor signals $3I_0$, I_{A2} and V_{BC} are applied directly to inputs of AND gate 126, and to inputs of AND gate 128 via polarity inverters 130, 132 and 134. The outputs of AND gates 126 and 128 are applied to time-delay unit 138 via OR gate 136. If the time of positive coincidence, or the time of negative coincidence, is at least 5.55 msec, the time-delay unit provides a true output signal T_{AG}, which may be used to initiate tripping of the phase A power circuit breaker 26, as the high or true output T_{AG} indicates a phase A to ground fault on the three-phase electrical power system 20.

The monitors 60 and 62 for phases B and C, respectively, are similar to the phase A monitor 58, and thus need not be described in detail.

Phasor diagrams for selected fault conditions will now be examined, to illustrate the effectiveness of the methods and apparatus of the present invention in detecting a single-phase-to-ground fault, and for correctly identifying the faulted phase. First, a single-phase-to-ground-fault will be examined, with phase A being the faulted phase. As shown in Figure 7, the phase A current I_A will lag the phase A voltage V_A by the fault angle, which is approximately 75°. The $3I_0$ current and the negative sequence current referenced to phase A are substantially in phase with I_A, and with one another. The phasor V_{BC}, shown in Figure 6, is about 15° out of phase with the $3I_0$ and I_{A2} signals. Thus, the phase A monitor will output a true signal T_{AG}. Figure 7 also illustrates that jV_{A2} may be used instead of I_{A2}, as jV_{A2} is close to being in phase with $3I_0$.

Figures 9A and 9B are phasor diagrams which illustrate the signals applied to the phase monitors for phases B and C, respectively, when a phase A to ground fault exists. As illustrated, the negative sequence currents referenced to the B and C phases are 120° out of phase with the signal $3I_0$. Thus, the monitors for phases B and C provide low output signals T_{BG} and T_{CG}, respectively.

A phase-to-phase-to-ground fault will now be considered, with phases B and C being selected as the faulted phases for purposes of example. The signals applied to the phase A monitor are shown in Figure 10 for the situation where the net impedance from the fault to the measuring point is inductive. While the $3I_0$ signal and the negative sequence signal I_{A2} referenced to phase A are in phase for the unfaulted phase, improper selection of phase A as a faulted phase is prevented by signal V_{BC} which is almost 180° out of phase with these signals.

Figure 11 is a chart which sets forth various fault configurations and the phasor signals applied to the phase A monitor or selector, which illustrates that a phase selector for indicating single-phase-to-ground faults, and the faulted phase, will operate correctly for all fault configurations.

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Düsseldorf, Nov. 2, 1982

8255 EU

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CLAIMS:

1. A method of detecting a single-phase-to-ground fault in a three-phase electrical power system, comprising the steps of:

providing a first phasor signal ($3I_0$) responsive to the sum of the three phase currents (I_A, I_B, I_C) in the three-phase system,

providing a second phasor signal (I_{A2}) indicative of a predetermined negative sequence quantity, referenced to the phase being monitored, and characterized by

providing a third phasor signal (V_{BC}) responsive to the quadrature voltage for the phase being monitored,

comparing the phase angles of said first, second and third phasor signals,

and providing a signal (T_{AG}) indicating a single-phase-to-ground fault of the monitored phase when the step of comparing the phase angles detects a predetermined phase angle relationship.

2. Apparatus for detecting a single-phase-to-ground fault in a three-phase electrical power system, operating according to the method of claim 1, comprising:

means [Figs. 1, 3 (64)] providing a first phasor signal ($3I_0$) responsive to unbalanced current in the three-phase system, means [Figs. 1, 3 (76)] providing a second phasor signal (I_{A2}) indicative of a negative sequence quantity, referenced to the phase being monitored, and characterized by comprising:

means [Figs. 2, 5 (90)] providing a third phasor signal (V_{BC}) responsive to the quadrature voltage of the phase being monitored,

comparison means [Fig. 2 (58)] comparing the phase angles of said first, second and third phasor signals,

said comparison means providing a signal (T_{AG}) which indicates a single-phase-to-ground fault on the three-phase system, with the fault being on the phase being monitored, when the phase angles have a predetermined relationship.

3. The apparatus as claimed in claim 2 wherein the three-phase electrical power system has phases A, B and C, phase voltages V_A, V_B and V_C, line voltages V_{AB}, V_{CA} and V_{BC}, and phase currents I_A, I_C and I_B, and for identifying the faulted phase, comprising:

the means providing the first phasor signal ($3I_0$) is responsive to the sum of the phase currents I_A, I_B and I_C,

the means providing the second phasor signal and fourth and sixth phasor means [Figs. 1, 3 (78, 80)] providing signals (I_{B2}, I_{C2}) are responsive to a negative sequence quantity referenced to phases A, B and C, respectively,

the means providing the third phasor signal and means [Fig. 2 (92, 94):Fig. 5] providing fifth and seventh phasor signals are responsive to V_{BC}, V_{CA} and V_{AB}, respectively,

and the comparison means including first detector means (138) for providing an output signal (T_{AG}) indicating a phase A-to-ground fault when said first, second and fifth phasor signals are within a predetermined number of electrical degrees of one another, second detector means (60) for providing an output signal (T_{BG}) indicating a phase B-to-ground fault when said first, third and sixth phasor signals are within said predetermined number of electrical degrees of one another,

and third detector means (62) for providing an output signal (T_{CG}) indicating a phase C-to-ground fault when said first, fourth and seventh phasor signals are within said predetermined number of electrical degrees of one another.

4. The apparatus as claimed in claim 2 or 3 wherein the quadrature voltage is the line-to-line voltage whose phase angle is normal [Fig. 6 ($V_{BC} \perp V_A$)] to the phase angle of the phase voltage being monitored.

5. The apparatus as claimed in claim 2 or 3 wherein the predetermined relationship of the phase angles is the phase angles all being within a predetermined number of electrical degrees of one another.

6. The apparatus as claimed in claim 5 wherein the predetermined number of electrical degrees is 60°.

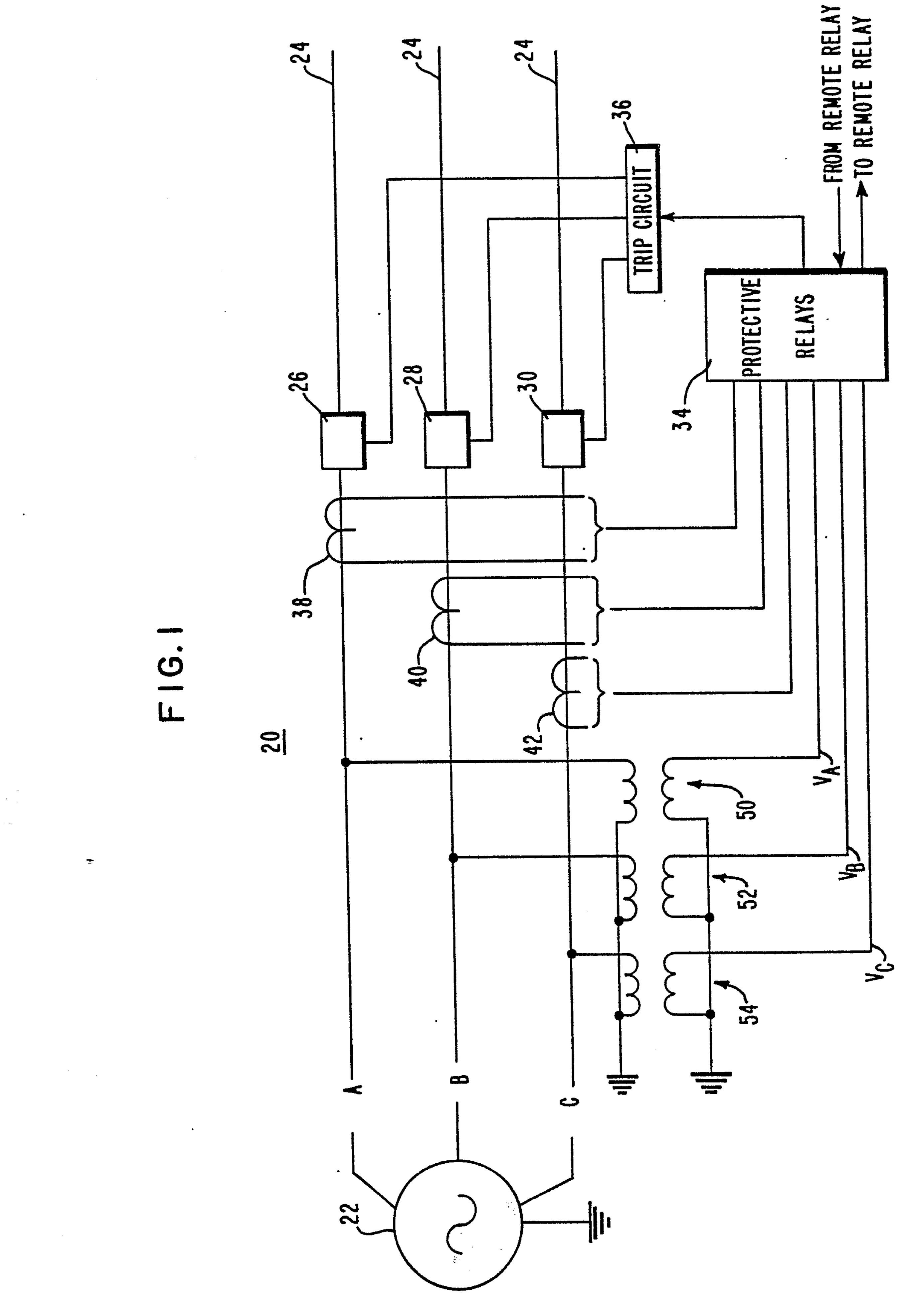
7. The apparatus as claimed in claim 2 wherein the comparison means compares the coincidence of a selected polarity of the first, second and third signals, and wherein the comparison means provides an output signal (T_{AG}) when the coincidence of like polarities exceeds a predetermined period of time.

8. The apparatus as claimed in claim 7 wherein the predetermined period of time is 120 electrical degrees.

9. The apparatus as claimed in claim 2 or 3 wherein the negative sequence quantity is the negative sequence current.

10. The apparatus as claimed in claim 2 or 3 wherein the negative sequence quantity is the negative sequence voltage [Fig. 7 (V_{A2})] phase shifted by +j.

FIG. I



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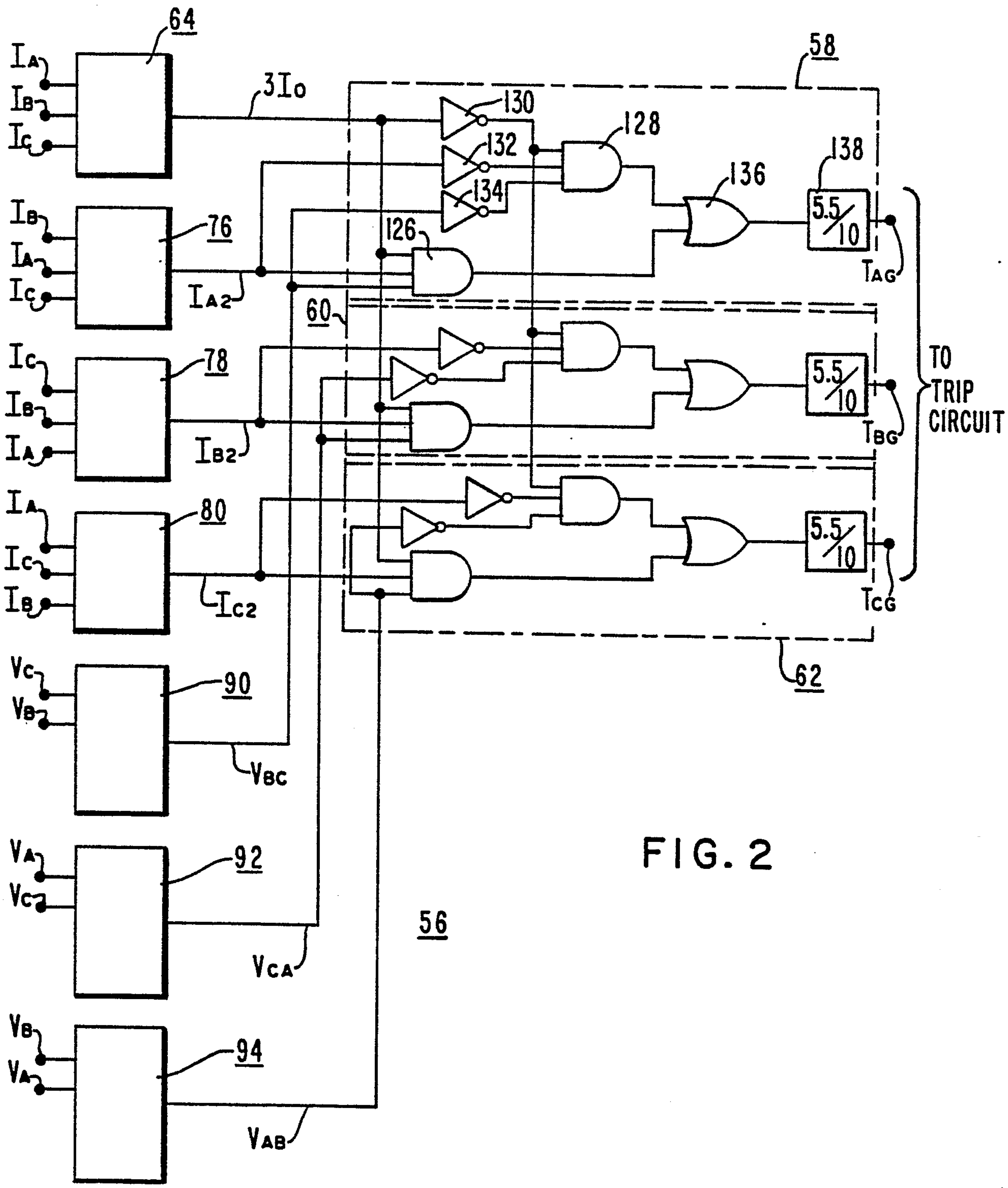


FIG. 2

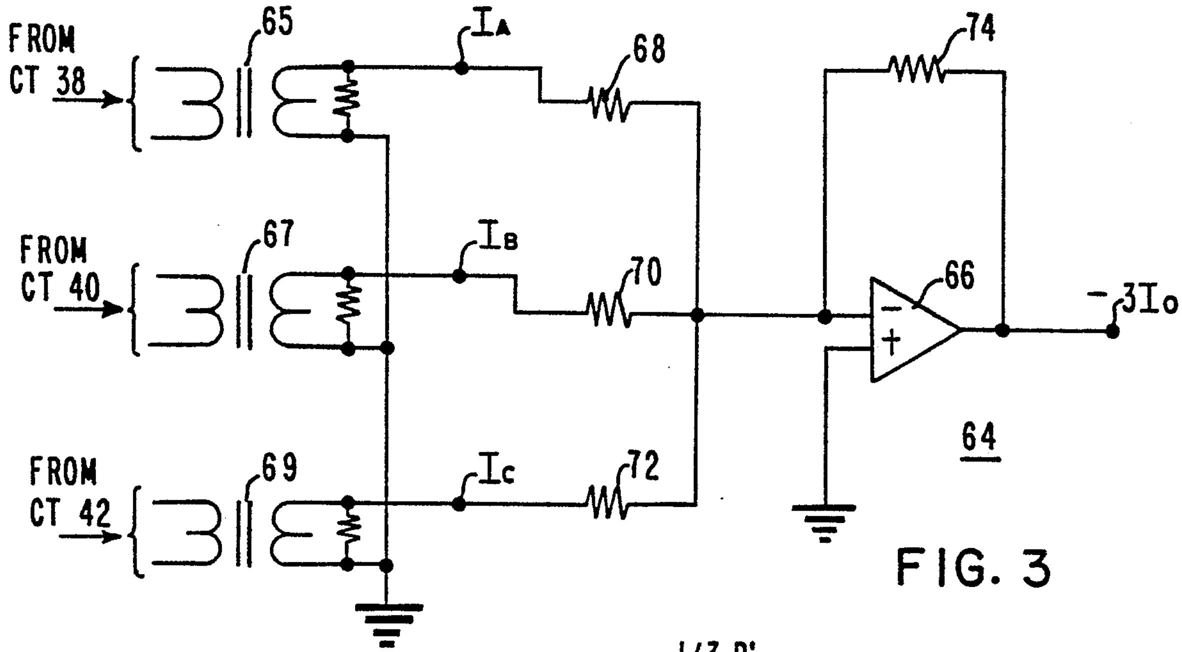


FIG. 3

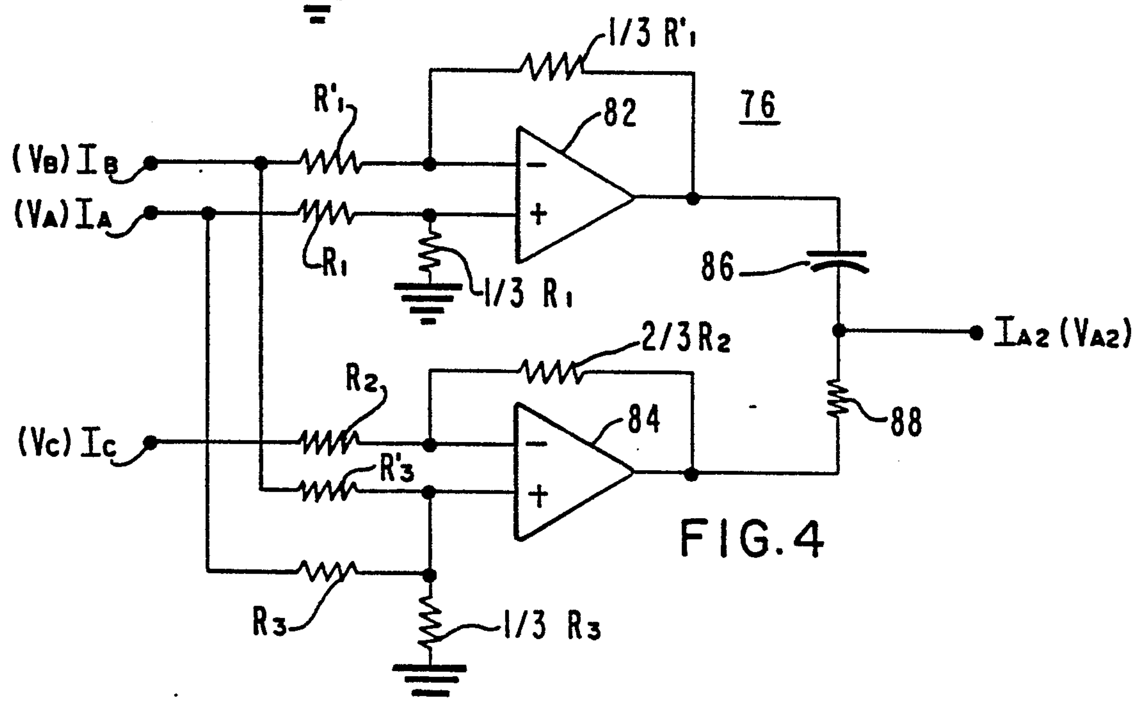


FIG. 4

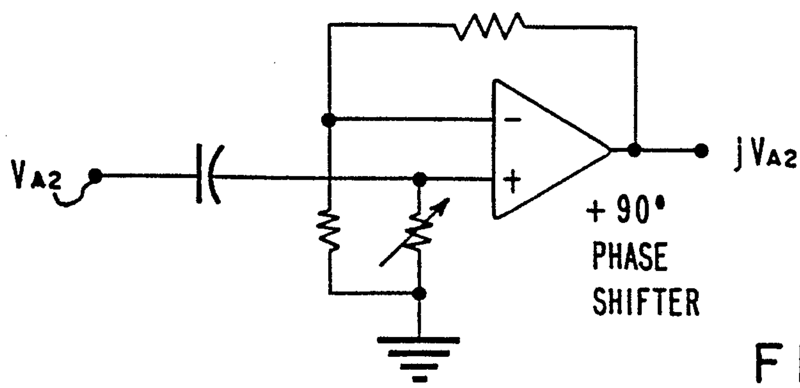


FIG. 4A

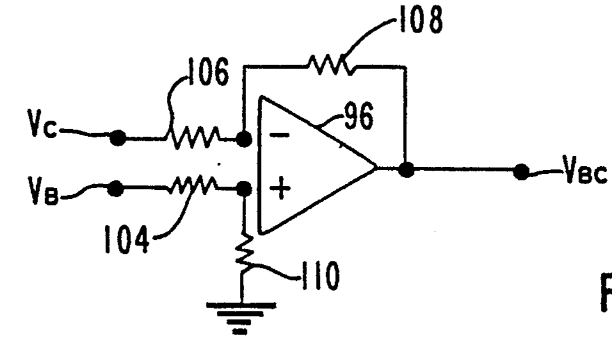


FIG. 5

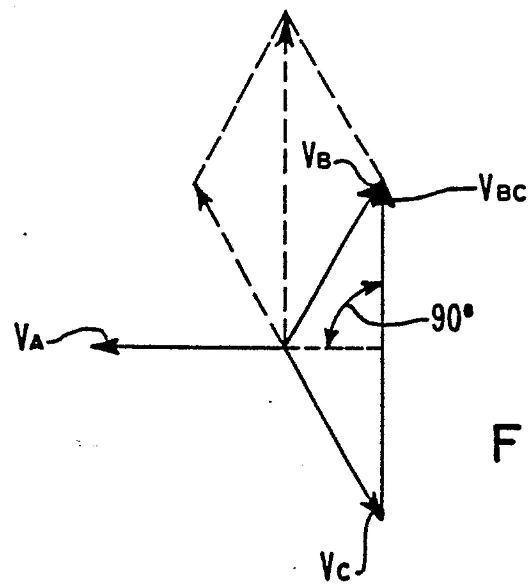


FIG. 6

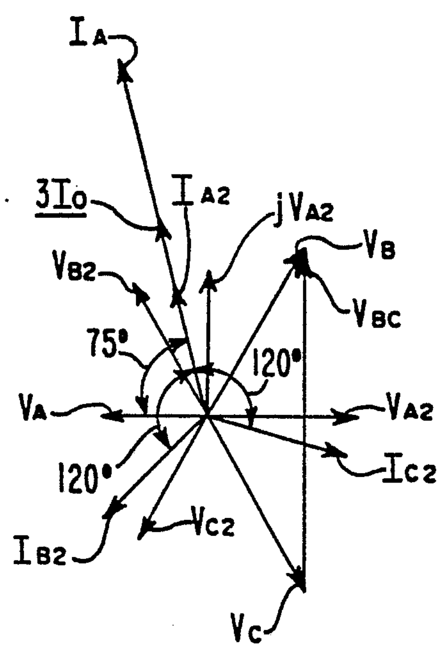


FIG. 7

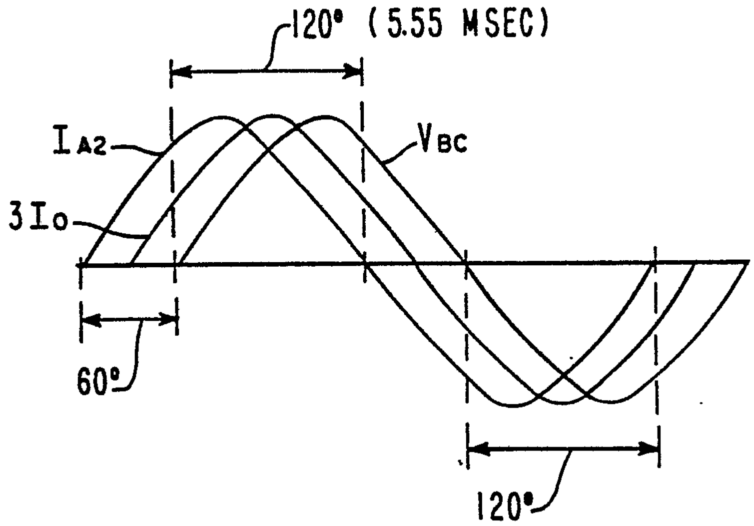


FIG. 8

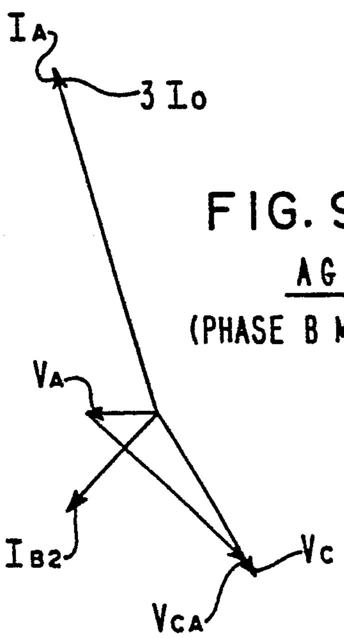
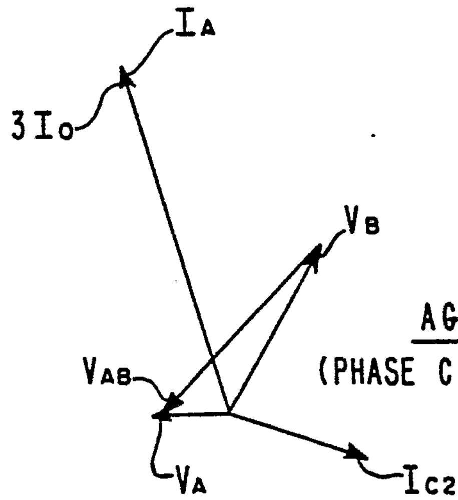


FIG. 9A

AG
(PHASE B MONITOR)



AG
(PHASE C MONITOR)

FIG. 9B

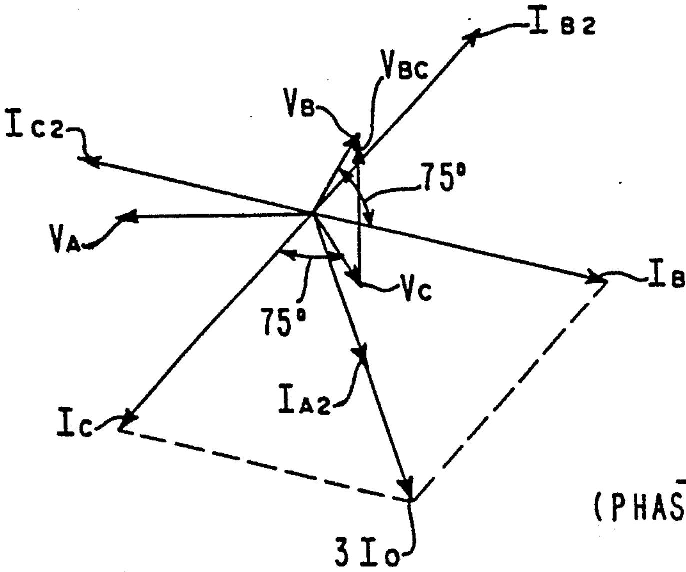
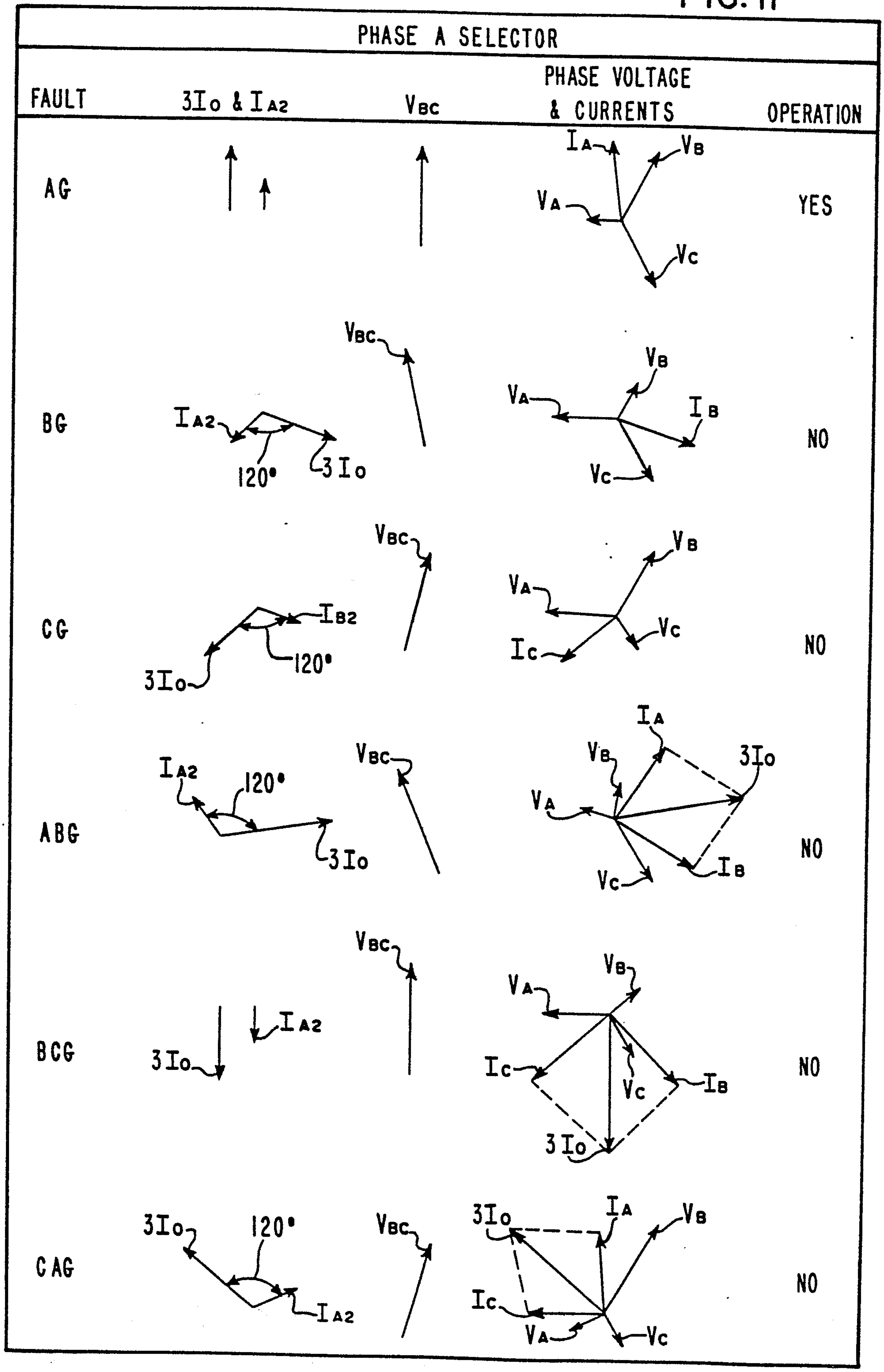


FIG. 10

BCG
(PHASE A MONITOR)

FIG. 11


PHASE A SELECTOR
FAULT
3Io & IA2
VBC
PHASE VOLTAGE & CURRENTS
OPERATION
AG
IA
VB
VA
VC
YES
BG
VBC
VB
VA
IB
IA2
120°
3Io
VC
NO
CG
VBC
VB
VA
IB2
VC
IC
120°
3Io
NO
ABG
IA
VB
3Io
VBC
IA2
120°
VA
3Io
IB
VC
NO
BCG
VBC
VB
VA
IA2
3Io
IC
VC
IB
3Io
NO
CAG
3Io
120°
VBC
3Io
IA
VB
IC
IA2
VA
VC
NO

European Patent Office

EUROPEAN SEARCH REPORT

0079504

Application number

EP 82110007.0

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
A	CH - A5 - 573 673 (GENERAL ELECTRIC) * Fig. 1,4; claims * --		G 01 R 31/04
A	CH - A5 - 597 707 (WESTINGHOUSE) * Fig. 1; main claim * --		
A	US - A - 3 924 160 (MAIER) * Fig. 4; abstract * --		
A	US - A - 3 377 551 (LE DOUX) * Fig. 1,2; claim 1 * --		
A	AU - B - 426 585 (COUNCIL/CITY/BLUE MOUNTAINS) * Fig. 2,3 * ----		TECHNICAL FIELDS SEARCHED (Int. Cl. 3) G 01 R 31/00 H 02 H 3/00

X The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	28-01-1983	KUNZE

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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L : document cited for other reasons
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